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# Foreign Animal Disease Report

United States  
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Health Inspection Service

Veterinary Services



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## Current Events

Vesicular  
Stomatitis  
Update

The present outbreak of vesicular stomatitis (VS) started into its second year in June. During the past year, approximately 1200 investigations were conducted, with New Jersey type VS identified on 614 premises in 14 States.

The most recent case of VS occurred in Nebraska. Virus was isolated from tissues collected from a yearling bull, on May 25. VS antibodies were not found and this animal died 2 days after the initial samples were collected. The bull originated in Colorado and was sold through an auction market in Missouri on December 5. No additional VS virus was found in animals that had contact with the bull or in other cattle sold at the Missouri market. Vesicular stomatitis was not diagnosed in the herd in Colorado from which the bull came and the owner did not observe signs suggestive of VS. (Dr. K. A. Hand, 301 436-8065)

Exotic  
Newcastle  
Disease  
Update

Exotic Newcastle disease was diagnosed in six States during the period March 21 through June 10, 1983. The 22 positive cases were in California (11), Texas (6), Nevada (2), Kentucky (1), New York (1), and Florida (1). Except for Texas, exotic Newcastle disease viruses isolated during this period were from young yellow-naped Amazon parrots of unknown origin.

The six cases in Texas were small backyard flocks consisting mainly of gamefowl. One of these occurred at Laredo after a Mexican gamecock was taken to several premises for the treatment of a disease condition. This bird and about 60 percent of the birds in the flocks it contacted died before regulatory officials arrived. All infected and exposed birds were depopulated. One case occurred in the Los Morenos area and is thought to have resulted from the movement of birds to and from Mexico. It was unofficially reported that three nearby communities in Mexico were having severe death losses in chickens.

There are no commercial poultry operations in the two affected locations in Texas. The last occurrence of exotic Newcastle

245 5.7  
Haiti  
ASF/Program  
Reaches Goal [ ]

disease in Texas commercial poultry was during the spring of 1974 at El Paso. (Dr. K. A. Hand, 301 436-8065)

The slaughter phase of the **African swine fever** (ASF) campaign in Haiti was completed June 15 according to an announcement by officials of the project for ASF eradication and swine industry development.

Haiti was the last foothold of ASF in the Caribbean, where this disease represented a threat to swine production in the western hemisphere.

The project began elimination of Haiti's entire swine population in May 1982, as the most effective and efficient way to eradicate highly contagious ASF virus from the country.

A total of \$9,548,860 in indemnity was paid to swine owners for the 384,391 swine eliminated. Only a herd of 70 native swine remains under quarantine on an offshore island, the Ile de la Tortue.

Eradication program officials now face the crucial last stages of the program. These involve cleaning and disinfecting all swine premises, investigating to assure that all pigs were found and slaughtered, and importing about 2,000 certified pathogen-free swine to place as sentinels on 400 to 600 premises to check for possible remaining virus.

100 Officials expect the last stages of the eradication campaign to be completed by December of this year. If no ASF outbreaks occur in sentinel swine and other requirements are met, the country could be declared ASF free as early as January 1984. (Dr. J. A. Downard, 301 436-5256, and APHIS News Center, 301 436-7799)

World  
Situation  
Update

A review of recent events on the animal disease scene worldwide appears to again point out the fact that countries at a higher state of development, while not always able to prevent invasions of exotic animal diseases, are better able to cope with them. For example, the last outbreak of foot-and-mouth disease in Denmark was stopped after affecting only two premises. Similarly, a recent outbreak of African swine fever on the Italian mainland was confined to two premises. Repeated occurrences of **bovine pleuropneumonia** in France appear to respond to energetic countermeasures. This disease was recently reported in Portugal.

Other areas of the world are less fortunate. **Rinderpest** is capturing the headlines. Once thought to be almost eradicated in Africa after an extensive vaccination campaign, the disease proliferated due to lack of followup effort and has again reached proportions where only another massive campaign covering many countries gives any hope of coping with it. Such a campaign is being organized. Great difficulties are being encountered in finding donors to support and execute a new vaccination campaign. The disease caused heavy losses in Nigeria, Cameroon, and Chad. It is also reported in Niger and Oman. It has not been completely suppressed in Israel.

Italy experienced an outbreak of **sheep pox**. This disease was also recently reported in Morocco, Kuwait, and Turkey.

There have been no recent changes in the distribution of **foot-and-mouth disease**. It was reported in South Africa, Kenya, Libya, Morocco, Somalia, Tanzania, Zimbabwe, Argentina, Colombia, Ecuador, Peru, Saudi Arabia, United Arab Emirates, Hong Kong, India, Malaysia, Oman, Thailand, Yemen, Spain, Portugal, Turkey, and USSR. (Dr. H. J. Seyffert, 301 436-8285)

Bluetongue  
Type 2 Not  
Exotic

Serotype 2 bluetongue virus, new to the United States, was found in a herd of cattle owned by the University of Florida in Ona, Fla.

Of 20 bluetongue serotypes identified worldwide, four previously have been found in the United States.

This exotic virus was found in a sentinel herd that is tested regularly in an animal disease surveillance program. Researchers have not observed any signs of illness in the herd.

The surveillance studies are being conducted by the University of Florida as part of a cooperative effort of the university, the Florida Department of Agriculture and USDA.

Antibodies suggesting the new virus serotype were detected in blood samples collected during October 1982, and sent to the Animal Virus Research Institute, Pirbright, England. The virus was later isolated from blood samples submitted from Florida to the Arthropod-borne Animal Disease Research Laboratory of USDA's Agricultural Research Service in Denver, Colo. The virus, isolated in Denver, was identified as serotype 2 at USDA's Plum Island Animal Disease Center in Greenport, N.Y.

Epidemiological studies are in progress to determine distribution of this new serotype in Florida and the mode of introduction. (APHIS News Center, 301 436-7716)

Suspected  
Foreign  
Animal  
Disease

Approximately 75 disease investigations were conducted by specially trained foreign animal disease diagnosticians during the second quarter of calendar year 1983. Most investigations were related to vesicular conditions in cattle. However, investigations of suspected hog cholera and exotic Newcastle disease were quite numerous. (Dr. K. A. Hand, 301 436-8065)

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Veterinary  
Services in  
Central  
America and  
Panama [1-4]

12 The U.S. Department of Agriculture has provided staff veterinarians under bilateral assistance agreements for all of Central America since 1974. The principal task associated with 13 these agreements is surveillance for foot-and-mouth disease and rinderpest, but in recent years has been extended to include most of the diseases exotic to the United States.

X  
Laboratories

To support diagnostic work<sup>4</sup> on vesicular diseases in the Central American region, a special cooperative laboratory<sup>29</sup> was built in Panama in 1982. This laboratory will speed diagnostic



services. Previously, transportation to laboratories in Rio de Janeiro, Brazil, and Plum Island, N.Y., generally required several days. The Pan American Health Organization for many years has provided laboratory services, training, and cooperative ventures in animal health within the region. To a more limited extent, the Food and Agriculture Organization of the United Nations has provided training opportunities for veterinary specialists.

Veterinary services to livestock and poultry producers in Central America are generally considered adequate to marginal. There appear to be sufficient numbers of veterinarians, about 95 percent of whom are employed by the Government in the respective ministries of agriculture. Activities include regional veterinary service support to livestock producers, brucellosis and tuberculosis campaigns, rabies control, and laboratory services, similar to the federal services in many countries. About 5 percent of private veterinarians work primarily as small animal practitioners, equine specialists, bank employees, and in poultry production.

There is often considerable difficulty in providing adequate support for local government veterinarians. There is a general shortage of vehicles, gasoline is very expensive, and many veterinarians cannot adequately cover their assigned territories in a routine fashion. Veterinary supplies are limited and expensive. Diagnostic aids for laboratories are deficient in most instances, and outside sources must be relied upon for antigens, culture media, and certain chemicals. However, the number of laboratories available seems sufficient.

#### Veterinary Laboratories in Central America and Panama

<u>Country</u>	<u>Number Federal or National</u>	<u>Number Independent</u>
Belize	2	
Costa Rica	1	
El Salvador	3	1
Guatemala	1	3
Honduras	2	
Nicaragua	1	
Panama	10	

There is a tendency toward development of regional diagnostic centers, which certainly seems a practical idea for such a small geographic area. However, transportation of samples to laboratories is often impeded by an inefficient transportation system.

#### Veterinary Organizations

A number of veterinary organizations have contributed materially to an understanding of livestock and poultry diseases in Central America. Perhaps the most outstanding is the International Regional Organization for Animal Sanitation (OIRSA), established

over 20 years ago by Dr. Carlos Meyer Arevalo. It is a cooperative venture of the ministries of agriculture of all Central American countries, Mexico, and Panama. It was obvious that each small country could not individually develop an adequate system of animal health programs, but by cooperating and pooling scientific and financial resources, such a system can be realized.

Exotic disease prevention and surveillance are of particular importance. At the present time, the organization is only modestly surviving due to devaluation of currencies and frequent changes of cooperating government officials.

The Animal Health Division of the Interamerican Institute for Cooperation in Agriculture (IICA) was recently formed within the Organization of American States (OAS) and has initiated several important programs within the Central American region.

#### Veterinary Schools

There are two veterinary schools in the region, one at Guatemala City, Guatemala, and the other at San Jose, Costa Rica. Each has a professional staff engaged both in teaching and disease diagnostic services.

#### Geographic Factors

Travelers in Central America sometimes remark that while there is much commonality, there is also an equal diversity. To a certain extent, the same may be said of the animal disease situation. The total area is not much larger than the upper New England States, yet topographical features are such that there is considerable isolation.



Ranges of mountains interlaced with only a few major roads, winding coastlines, peninsulas, and almost impenetrable coastal marshlands blend to separate much of the area into unique ecological niches. These same physical barriers, to a major extent, confine the human population along with their accompanying domestic animals. For example, in the Darien jungle region of southern Panama, the ocean tides often rise 8 meters and serve a cleansing function. Many disease vector populations seem unable to survive there. People often must live only on higher terrain in houses built on stilts.

The government has declared that no domestic animals will be raised for market within the Darien jungle and for 40 kilometers north of the Panama-Colombia border. Only a limited number of locally consumed hogs are permitted there. This program is intended to prevent foot-and-mouth disease entry into Panama from Colombia. For the next hundred miles into Panama all domestic animal production is strictly controlled, with ear tag identification and regular veterinary inspections. Animals departing the area go only to slaughter under permit.

Military  
Interference

An extremely complicating factor in the capacity of veterinarians to do field work is the presence of active military or guerrilla fighting in El Salvador, Guatemala, Honduras, and Nicaragua. In summarizing the situation, one can say that up to half of the territory may be unavailable for routine veterinary surveillance and service activity at any one time. There are periods of quiet interspersed with periods when it appears impossible to venture forth from the most protected areas. This materially affects the gathering of statistical data. It also affects commerce and the movement of animals to market.

Diseases  
Present

The following list lumps together the reports of livestock and poultry diseases from the ministries of agriculture of the Central American countries and Panama. Foot-and-mouth disease, rinderpest, and African swine fever have not been diagnosed in these countries.

Vesicular stomatitis--New Jersey type and a few Indiana type strains are present, predominantly in highland regions.

Hog cholera--in Guatemala, Belize, Honduras, Nicaragua, and El Salvador.

Rabies--common in all countries of Central America. Vampire bats spread rabies in domestic animals. The disease is uncommon in Panama among pets (1 cat in 1982), but there are losses in cattle each year. Several human cases occur annually in all countries except Panama.

Brucellosis--generally quite low incidence in cattle, sheep, goats, and swine with routine testing showing herd averages of 0.25 to 1.5 percent. Occasional herds have incidence of 5 to 7 percent.

Equine infectious anemia--12 to 19 percent incidence in tested areas.



Tuberculosis--0 to 0.25 percent incidence.

Bovine leucosis--presently diagnosed in Belize.

Anthrax, tetanus, and blackleg--common in all countries.

Newcastle disease--suspected in Belize; confirmed in Nicaragua and Honduras.

Equine babesiosis--30 to 70 percent of horses in El Salvador and Guatemala have antibodies for babesia.

Canine parvovirus--continues at steady rate in Belize and Panama.

Canine leptospirosis--common in Belize and Panama.

Cattle leptospirosis--in Guatemala.

Screwworms--in all countries.

Intestinal parasites--said by numerous veterinarians and ranchers to be the biggest problem in Central America.

Anaplasmosis and piroplasmosis--quite common throughout Central America.

Africanized bees--recently stung four horses to death in southern Panama. Also found in Costa Rica. (Dr. C. M. Barnes, Panama telephone 64-0222 or 63-6022)

## **News brief...**

### **FAO Activities in Animal Health**

Activities of the United Nations Food and Agriculture Organization (FAO) in the area of animal health were discussed June 16, 1983, at the APHIS-VS Emergency Programs Information Center, Hyattsville, Md. by FAO Animal Health Service Chief, Dr. Y. Ozawa.

Twelve veterinarians work in the Animal Health Service at FAO headquarters in Rome. They specialize in various technical fields, such as disease intelligence, veterinary education, general veterinary services, bacteriology, virology, foot-and-mouth disease, tick control, tsetse fly and trypanosomiasis control. Experts in other FAO services deal with veterinary subjects, such as artificial insemination and reproductive disorders, meat inspection, poultry production, and health. In addition to the staff at headquarters, professional staff at each of the four regional offices deal with animal production and health matters.

In 1982, there were 215 FAO livestock projects with budgets of \$131 million. Of these, 87 were animal health projects with 92 experts and 26 consultants.

Program activities include the organization of expert consultations, seminars, workshops, and training courses. Various manuals, handbooks, guidelines, and other publications

including the World Animal Review and the FAO/WHO/OIE Animal Health Yearbook, are published. Small grants are provided for research contracts on selected subjects.

Field activities include control of livestock diseases of major economic importance, control of ticks and tick-borne diseases, and development of veterinary services. Animal health activities are coordinated internationally in the areas of disease control, international agencies, research, and technical cooperation among developing countries. This cooperation involves regional and subregional veterinary schools, training centers, reference laboratories, and vaccine banks.

Dr. Ozawa expressed concern that the resurgence of rinderpest in Western Africa in 1979 and 1980 is continuing. There is need of another international campaign for rinderpest control with a view to its eventual eradication. (Adapted by Dr. E. I. Pilchard from a report by Dr. Y. Ozawa)

## 245 **Focus on...** **Caliciviral Disease** [1-1]

### Calicivirus Groups

Caliciviruses are becoming associated with a whole cluster of disease manifestations that are occurring in an increasing number of animal species. Viruses that fit the morphologic class of calicivirus can be divided into three general groupings. Two are of no great significance for the purposes of this report. The first of these is the feline calicivirus. It can cause a glossitis and pneumonitis in cats.

The second group of caliciviruses or calicivirus-like agents have never been isolated in vitro but have been repeatedly observed by electron microscope in diarrhetic feces. These are classed as caliciviruses primarily on the basis of their morphology. They have been seen in infant diarrheas occurring in children in Scotland and Japan and in a number of water or food borne gastroenteritis outbreaks in adult humans on cruise ships, in nursing homes, and in similar settings. The same or similar calicivirus or calicivirus-like agents have been associated with diarrhea in calves and piglets.

The third group of caliciviruses is the subject of this report. They are of considerable interest to us because they are all classified as either vesicular exanthema of swine virus (VESV) or indistinguishable from VESV. This division is based on historical events, not virus differences. All the viruses isolated prior to 1956 were from domestic swine and were called VESV. Those isolated subsequent to that time have been designated indistinguishable from VESV. One of these was isolated from rectal and nasal specimens from domestic swine. Vesicles were not observed in these animals and, even though virus capable of causing vesicular exanthema was found, the disease was absent.

### VES Classed as a Foreign Disease

Vesicular exanthema of swine (VES) last occurred in the United States in 1956, and therefore is classed as a foreign animal disease. There is a paradox here in that all known occurrences of this disease have been within the United States or directly

traceable to sources within this country prior to 1956. There are numerous serotypes of viruses indistinguishable from VESV, which are active in reservoir species within the United States. Several have been tested and found to cause typical vesicular exanthema in experimentally infected pigs and spread to contact pigs. Some of the more recent isolates found in nonporcine hosts were shown to be more virulent for swine than some of the VES types isolated from diseased pigs prior to December 1956. Recent work indicates that viruses in this group are not host specific, contrary to earlier data suggesting swine were the only natural hosts.

Pathogenicity  
May Be  
Changing

Today, this group of caliciviruses seems to be teetering on the brink of being discovered as important pathogens that cause disease in far more animal species than just swine. Very pressing questions are arising. Are caliciviruses rapidly adapting to a number of new and distantly related host species and in the process becoming quite host nonspecific? Are they zoonotic? Are all the factors responsible for the 1952-54 VES outbreak now present? Regulatory veterinary medicine may need to once again address the calicivirus phenomena, taking into account new and changing concepts, not only for these agents but for their host species as well.

History

VES first came to the attention of the regulatory officials in April of 1932 in Buena Park, Orange County, Calif., and was tentatively diagnosed as foot-and-mouth disease. Initial outbreaks involved about 19,000 head of infected or exposed swine. All were killed and buried, and indemnities costing about \$200,000 were paid, ending the episode.

One year later, the disease reappeared in San Diego County, Calif. However, at that time it was said not to be foot-and-mouth disease but instead a new disease called VES. A year later, the disease appeared in the San Francisco Bay area and was subsequently controlled by strict quarantine. The years 1935 and 1936 each saw repeats of this same pattern. Each time the disease erupted, it was contained. In retrospect, there appeared to be 10 distinct outbreaks of VES between 1932 and 1936. Each was contained and eradicated.

There were no outbreaks of VES during more than 3 years between 1936 and December 1939. Then, the character of the disease changed. For the next 16 years, VES would not be contained and, in 1952, it spread from California to all the major swine producing areas of the United States. In 1954, a Federal eradication program was initiated and laws requiring that garbage be cooked before being fed to swine were enforced.

The last VES outbreak recorded was in Secaucus, N.J., in 1956. In 1959, VES was declared eradicated and designated a foreign animal disease.

Raw Garbage  
Feeding Spreads  
VES

Out of the events of 1932-36 and 1939-56, there is a hint of something missing. After 1939, the cycle appears to have shifted to a swine-to-swine cycle through the medium of raw garbage. Infected pork scraps in raw garbage were found to be



the source of virus. This would account for the failure of quarantine and slaughter to control the disease. The apparent key to outbreaks from 1932 to 1936 was direct introduction of the virus from some source outside of swine herds. The disease was always recognized and contained, but the garbage component that served as the source of virus was not identified. Consequently, the information necessary to prevent reintroduction of VES into swine was not developed. It seems likely that a lack of perseverance to develop useful information on the virus-bearing component of garbage may be the breakdown point which allowed contaminated raw garbage from California port cities to be fed to swine in 1939. This ultimately resulted in the nationwide spread of the disease and an expenditure of \$39 million in direct costs to eradicate the disease.

#### Marine Sources of Calicivirus

Beginning in 1972, caliciviruses that could be classified as new serotypes of VESV were isolated from a variety of ocean sources. At first, they were found in marine mammals (seals) where they caused abortion and vesicular lesions on flippers. Next, they were isolated from ocean fish, such as the opaleye (*Girella nigricans*), which no doubt served as a primary ocean reservoir for this group of viruses.

In November 1981 another surprising event occurred. A calicivirus isolated from calves on the Oregon coast caused vesicular lesions at sites of injection in domestic swine. Possible marine origin of the calf virus is not yet determined, nor is the disease potential for cattle fully understood. Significantly, calves appear to have become persistently infected with a naturally acquired virus, which can cause vesicular lesions in swine. Virus is shed from infected calves, even in the presence of high antibody titers.

#### Research and Regulations

The series of historical events from 1932 to 1981 serves to remind us that veterinary medical regulations and research must proceed together. Attempts to regulate or control animal diseases with an incomplete understanding of their nature may not achieve the desired results.

#### Virus Characteristics

Caliciviruses are single stranded RNA viruses with icosahedral symmetry. They are lipid-solvent resistant and are therefore naked or nonenveloped. Their diameter is 34-36 nanometers and their morphology is characterized by distinctive surface cups or calyxes. It is from these structures that they derive their name, calicivirus.

The virion is degraded at pH 3.0, and 50°C. Divalent cations, for example magnesium chloride, will not stabilize the virus in the presence of heat and instead enhance degradation. This characteristic differentiates caliciviruses from some of the other small RNA viruses such as enteroviruses. Caliciviruses survive quite well in sea water and will live indefinitely in buffered solutions at 4°C in the presence of reducing agents such as l-cysteine. Virus titer drops four logs in 14 days in sea water at 15°C. Historically, 2 percent sodium hydroxide has been used to disinfect calicivirus-contaminated surfaces. Caliciviruses have a single major polypeptide, their buoyant

density in cesium chloride solution is 1.36-1.38. Their sedimentation coefficient is 180s-207s. They have been isolated most successfully in vero cells and pig kidney cells.

#### Disease Manifestations

In swine, VES is an acute febrile disease with vesicles appearing around the snout, lips, and coronary bands. Typically, primary lesions occur within 24 hours at the site of viral entry, then 48-96 hours after exposure, secondary lesions appear at other sites.

The disease mimics foot-and-mouth disease, vesicular stomatitis, and swine vesicular disease. Abortion, agalactia, runting, myocarditis, and encephalitis have also been reported in infected swine. Mortality in exposed swine herds has been low and morbidity quite variable, depending on the serotype of virus involved. Swine usually develop high levels of neutralizing antibodies and then eliminate the virus without setting up persistent infections. The major impact of the disease in swine is unthriftiness that simply makes pork production unprofitable.

Caliciviral disease in other species is far less studied than in swine. Vesicular lesions, abortion, pneumonitis, and encephalitis are all thought to occur in infected seals. Experimentally infected calves and monkeys show lesions at injection sites. Calves may also develop pneumonitis, and continue to shed virus for more than 6 weeks.

#### Laboratory Diagnosis

The diagnosis of calicivirus infection is based on isolating and identifying the virus from a typical lesion. The serum neutralization test (SN) has been most used, but has shortcomings in that it is type specific for the homologous virus and can therefore not be used to answer the larger question, "Has this animal developed antibodies to any of the other calicivirus types?" Other tests, using staphylococcal protein A binding of immunoglobulin G, are under investigation, as is a monoclonal antibody derived common antigen test. Complement fixation tests have also been used, but may have limited value in that many of the marine mammal serums are very anticomplementary.

The serologic surveys discussed in this report utilized serum neutralization of the specific virus serotype isolate from field cases. These tests are so type-specific that one animal may have a high SN titer and be absolutely negative to tests for all the other calicivirus types. The virus being tested is considered a new virus type if 100 infective doses of the virus are not neutralized by 20 times the antibody required to neutralize 100 infective doses of the homologous virus.

Immunoelectron microscopy has proven a useful diagnostic technique where antibody conversion can be shown using minimal quantities of test antigen and serum. This test gives a different cross reactivity than the serum neutralization test. It was used to show that two of the original VESV types were more closely related to feline calicivirus vaccine strain F-9 than they were to each other and all the other VESV types or any of the marine calicivirus types.



The number of different calicivirus types has become unwieldy. Thirteen serotypes were isolated from swine prior to 1956, 12 other serotypes are of marine origin, and an additional six probably new serotypes from a variety of sources have been identified, or are being processed.

Calicivirus Isolations		
Type	Origin	Year
VESV* (13 Types)	Swine	1932-1956
101 (Probably lost)	Swine	1932-1956
B34	Swine	1932-1956
A <sub>48</sub> -K <sub>56</sub>	Swine	1932-1956
SMSV**	Sea lion	
SMSV-1	California sea lion	1972
SMSV-2	Northern fur seal	1972
SMSV-3 (May be a mixture of SMSV-1 and SMSV-2)	California sea lion	1972
SMSV-4	California sea lion, domestic swine	1973
SMSV-5	California sea lion	1973
SMSV-6	California sea lion	1975
	Opaleye fish	1977
SMSV-7	Opaleye fish	1976
	Northern elephant seal	1976
	California sea lion liverfluke	1976
SMSV-8	Northern fur seal	1975
SMSV-9	California sea lion	1975
SMSV-10	Northern fur seal	1975
SMSV-11	Northern fur seal	1977
SMSV-12	California sea lion	1977
	Northern fur seal	1977

\* Vesicular exanthema of swine virus

\*\* San Miguel sea lion virus

Caliciviruses either untyped or isolated from miscellaneous species:

Walrus calicivirus	1978
Mink calicivirus	1978
Canine calicivirus (3)	1981-1983
Cetacean calicivirus - designated Tursiops type 1 (CCV-Tur 1)	1979
Reptilian calicivirus	1979
Primate calicivirus - designated Pan-1 (PCV-Pan 1)	1979
Bovine calicivirus	1981

Hosts Historically, swine were believed to be the only naturally infected host for VESV. In retrospect, this is almost certainly incorrect. Swine appear to have been an aberrant host species while the virus remained in reservoirs in marine primary hosts. The concept that caliciviruses are generally species specific simply will no longer hold. As early as 1975, data were generated showing that certain serotypes had a broad in vitro

host cell spectrum which, in one instance, included cells from several species of herbivores. These studies showed that most calicivirus serotypes would replicate well in canine, feline, and primate cell lines, less well in rodent and herbivore cells, and not at all in avian cells. Tests in vivo have generally borne out this same general pattern. In laboratory tests, the viruses generally failed to infect rodents. Those tested in horses, dogs, and mink occasionally caused infection. Three serotypes established infection in primates. Swine and pinnipeds were susceptible. At least four species of pinnipeds were naturally infected and one additional species was experimentally infected.

A rather broad host range is shown by certain calicivirus types. For example, one isolated from fish was also isolated from two species of seals. Another fish calicivirus was shown to infect domestic swine. A seal virus (SMSV-5) has been shown to experimentally infect fish, seals, primates, and pigs. One serotype of virus has been isolated from both seals and domestic swine and all had acquired the infections through natural exposure. A calf calicivirus infected pigs, and recently a dolphin isolate was shown to infect seals. The rule appears to be that these viruses have broad host spectrums.

#### Geographic Distribution

Evidence accumulated to date suggests that the caliciviruses are present in Pacific basin reservoirs and emerge in land mammals along the Pacific rim, from California to Alaska, the Bering Sea, and the opposing Russian coast. Wherever insular feral mammals have been tested along the California coast, they have shown antibodies to one or more of the known serotypes of caliciviruses.

Geographic ranges and/or distribution of animals with calicivirus antibodies:

<u>Terrestrial Mammals</u>	<u>Geographic Range and/or Distribution</u>
Feral swine	Santa Barbara Channel Islands
Foxes	Santa Barbara Channel Islands
Feral sheep	Santa Barbara Channel Islands
Feral buffalo	Santa Barbara Channel Islands
Feral donkeys	Santa Barbara Channel Islands
Domestic swine	California, Utah, and Idaho
Domestic cattle	Oregon coast

#### Marine Mammals

California sea lions	Baja, entire California coast
Northern fur seals	California, Oregon, Washington, Canadian, Alaskan and Russian coasts
Northern elephant seals	Baja, California coast as far north as Oregon and west as far as Wake Island
Sei whales	California coast (migration range not known)

Grey whales	Mexico, California coasts to the Chukchi Sea
Sperm whales	California coast (migration range not known)
Finwhale	California coast (migration range not known)
Bowhead whale	Arctic pack ice margin, Bering and Chukchi Seas
Walrus	Bering Sea
Stellar sea lion	California, Oregon, Washington, Canadian and Alaskan coasts

Pinnipeds live in the ocean and spend certain times on land; thus, they form a bridge between the land and sea. They eat fish and seem to serve as indicators of the calicivirus activity in an area. Using seals as sentinels, there appears to be a major focus of calicivirus activity off the California coast from Point Conception south. The number of individual animals with antibodies to a variety of caliciviruses is all very high in that region.

Based on serum antibody surveys, certain calicivirus serotypes have surprising geographic distributions. For example, the last two virus types of VESV to be isolated were <sup>J</sup>56 and <sup>K</sup>56. Both were isolated only once in Secaucus, N.J., in 1956. Yet half of all the California sea lions sampled along the California coast contained antibodies to these types (45 of 80 for J, and 34 of 80 for K). In addition, when four Bowhead Whale Sera were tested for VESV antibodies, one had antibodies to both J and K and another had antibodies to K. Bowhead whales stay at the margins of pack ice in the Bering and Chukchi Seas the year around, yet they appear to have contacted viruses identical or very similar to the two viruses isolated from pigs in New Jersey some 25 years earlier.

Other areas have not been studied as intensively as the Pacific Basin, but as yet there is no evidence to indicate that caliciviruses are resident in other oceans, although intuitively one would expect them to be there.

#### Threat to Livestock

We need only read the historical record to know that caliciviruses are a very real threat to the swine industry. Our question is "Can VES become widespread again?" The answer is a probable "No," because the risk of introduction, and spread by raw garbage has been reduced by enforcement of garbage cooking laws. However, VESV is classed as a foreign animal disease, and our second question is "Can it be introduced into our domestic animal herds?" The answer to that is "Yes." The mechanisms by which marine caliciviruses can be introduced into terrestrial animals are not all known, but several have been identified. It is now recognized that fish, at least some of Pacific Ocean origin, do carry caliciviruses infectious for swine and must be cooked prior to feeding to swine. Seal meat has been fed to mink and probably swine. The domestic swine populations in some areas of Utah and Idaho, where this practice was carried out, showed a high incidence of antibodies to various calicivirus types. Some of the seal meat was shown to harbor caliciviruses. Some insular populations of feral swine

along the California coast have SN antibodies that indicate exposure to many calicivirus types.

All six types of marine calicivirus that have been tested for swine infectivity produced lesions in experimentally exposed swine. Two of these caused secondary lesions in exposed swine and spread to contact exposed pigs, again causing typical clinical vesicular exanthema in swine. These two serotypes appear to be far more pathogenic for swine than several of the original VESV types isolated from pigs.

In Sonoma County, Calif., in 1976 a herd of swine was bled and tested for brucellosis and at the same time throat and rectal swab samples were collected for virus isolation. Calicivirus type SMSV-4 was isolated from three of these pigs. As mentioned above, this virus established infection and spread by contact in experimentally exposed pigs. The swine herd in question had brucella antibodies and was depopulated before isolation of the caliciviruses was generally known. For that reason, the decision whether or not to call this an outbreak of vesicular exanthema of swine was unnecessary. The lesson here is that VESV was introduced into our domestic swine, but did not produce an overt vesicular disease, which would have triggered a foreign animal disease regulatory response.

In another incident, caliciviruses from naturally infected calves were injected into pigs, causing vesicles at the sites of injection and antibody conversions in a single pen contact pig. The source of the virus infecting the calves is undetermined, but is thought to be of ocean origin. There are two very important points to consider. First, the virus established a persistent infection in the calves, raising the possibility that cattle can serve as a new land animal reservoir for the virus of an exotic swine disease. Second, VESV may have the potential to cause disease in cattle and spread widely, as it did in swine.

#### Zoonotic Potential

As far as is known there has never been overt disease in man attributed to any of the caliciviruses under discussion. There was one incident reported on St. George Island in the Bering Sea in 1974 that may be significant. A biologist working with adult seals having blisters on their flippers developed what was diagnosed by the U.S. Public Health Service nurse on the island as "blisters on the eyes." Treatment was ineffective. The individual was taken from the island for medical treatment, and the condition subsequently healed. Followup was not adequate to determine if the biologist's illness was related to the flipper lesions.

Currently, there are at least five reasons for suggesting that caliciviruses have zoonotic potential. First, they are routinely isolated in primate cell lines, and they usually grow quite well in human cell lines.

Second, three research laboratory workers who handled these agents developed antibodies for two different serotypes. There was no known overt disease associated with this, nor were there any known incidents of direct exposure to the virus.



The third reason is based on primate infectivity studies. Three calicivirus types (SMSV-4, SMSV-5, and VESV-<sup>C</sup>53) caused lesions at the site of inoculation in the African green monkey.

Fourth, a single serotype of calicivirus was isolated separately from five species of primates (gorilla, pygmy chimpanzee, spider monkey, douc langur, and silver leaf langur) at the San Diego zoo. The source of the agent remains unknown. The gorilla isolation was a necropsy finding incidental to other problems. The spider monkey had oral lesions containing virus. The douc langur had an encephalitis and other widespread lesions, and the virus was isolated from the brain. The silver leaf langur isolate was an incidental finding. The pygmy chimpanzee isolate was from a small blister on the lip. Virus was re-isolated 6 months later from the throat of the same chimpanzee, suggesting a persistent infection.

Last is the ability of caliciviruses to infect a wide range of host species. Two virus types infect fish, seals, domestic swine, and primates, while another type from fish infects two seal species and domestic swine. Because of this ability to infect widely divergent species, extension of the probable host range to man seems fully justified. In all probability these agents are zoonotic.

#### Research Needs

The greatest need toward resolving the caliciviral disease problem is to understand the survival of these agents in nature. What are their reservoirs and how are they transmitted? What are the mechanisms for introducing them into important domestic species? How do they establish persistent infections and in what species? How can important pathotypes be quickly and easily recognized without doing a series of animal infectivity tests? What are the geographic distributions? How can transmission cycles be broken and virus neutralized on contaminated surfaces or in processed foods? What test can be developed for conducting reliable serologic surveys? And, finally, what is the estimated economic impact of these agents?

All of these questions are the subject of proposed or ongoing research. The answer to each is especially important for improving capabilities to deal reliably with the threat of another costly incursion of vesicular exanthema.

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#### Errata

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In page four of the March 1983 issue (11-1), the word "Australia" should be deleted and the word "Austria" inserted. Australia is free of hog cholera.

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